Summary of Near Detector Electronics Layout

This document is an overview of the electronics layout for the Near Detector. The overview provides the basis of the decisions regarding rack locations, the desired access to each rack, the cables going into and out of the racks and the electrical power and cooling required in each rack. All of this information is provided in scattered locations in other documentation; this document strives to emphasize the physical features most pertinent to designing the outfitting criteria for the detector hall.

LAYOUT ALONG THE SIDE OF THE DETECTOR

The active side of the near detector is where most of the racks are located; there are 19 racks on the upper level, and 18 racks on the lower level. There are a few more (on order of 8) racks located at the rear of the detector.
The racks on the side are of three types, which will be called Front End (FE), Read Out (RO), and High Voltage (HV). HV racks hold one 1440 unit; there is one of these on each level. FE racks hold the phototubes and the crates of electronics boards, which hold the QIE chips; what Gary Drake calls Minder boards (there are also a few other board types in these Minder crates). The RO racks hold a 9u VME crate which contains what Gary calls Master boards and what the DAQ documentation calls the Read Out Board (ROB), which are in turn managed by the Read Out Processor (ROP), which sits in the same 9u VME crate.

Each FE rack holds 2 Minder crates. Each Minder crate can handle up to 4 M64 phototubes. Four Alner boxes holding 1 M64 each can be placed side by side, and fit into the width of the rack. The backs of the Alner boxes sit flush to the back of the rack, where the fibers from the detector enter. Access to the phototube is via the back of the Alner box. Cables from the front of the Alner box connect to the back of the Minder boards in the accompanying Minder crate. The Minder crate sits flush to the front of the rack. Each Minder crate can hold as many as 16 Minder boards; in addition, each Minder crate holds one Keeper board, a Trigger board, and a Clock board. Each FE rack is split into upper and lower halves, each half holding one Minder crate and up to four Alner boxes. Cooling coils and fans are placed just below each Minder crate and power supply, so these items do not overly warm up the phototubes. To be certain of having enough volume for cooling airflow within the rack, these FE racks are all 36" deep (standard racks are 30" deep).

There are 27 FE racks, 13 on the lower level, and 14 on the upper level; in addition, most of these FE racks are located alongside the upstream 1/2 of the detector, so they sit adjacent to the Calorimeter Section: 9 FE racks on each level to serve this upstream section. The clear fibers run from the detector planes into the back of the FE racks. Access to the back of these racks is required. No more than two racks are placed adjacent to each other, so that the back of the rack can be accessed from the aisleway. The space between the sides of adjacent pairs of racks is 15-18 inches. The detector support columns present some obstacle to the back of the racks, so the racks are placed 15" from the plane of the columns. In addition, all FE racks fit in the "bays" between posts, but may still be placed fairly close to a post, so the 15" at the back is needed to assure access.

The fiber bundles are supported in the longitudinal part of their run to the racks by a cable tray which is placed somewhere between the detector and the back of the FE racks. On the upper level, this tray could be located roughly where a guardrail would be placed, along the edge of the catwalk; this is similar to a proposed design for the Far detector. On the lower level, the tray could be mounted on or near the support columns. The precise tray location on either level has not yet been fully determined, beyond these general guidelines.

Each RO rack holds a single 9u VME crate. The VME crate can hold up to 12 Master boards, and will also hold one ROP, one clock distribution module, and perhaps something associated with the PVIC (I wasn't sure from the documentation if this was a separate board or a daughter board attached to the ROP). There are 8 RO racks total, 4 on each level. Three of them on each level serve the Calorimeter Section, and one on each level serves the Spectrometer Section. The RO racks are not full, and 3 of them will hold the 3 LED pulser calibration boxes, which are approximately the size of a 9u crate. RO racks are a standard 30" deep, and have no water-cooling requirement.

Cables connect Minder modules in the FE racks to Master modules in the RO racks. Each Minder has a single cable that must connect to a Master module. A Master module can handle up to 8 Minders. There is also a control cable that connects the single Keeper Module in each Minder crate to the crate's associated Master. The current understanding is that up to 12 Master modules can be placed in each VME crate. In this case, one RO rack is required for every three FE racks. The RO rack must be placed somewhat adjacent to the FE racks it serves, as the drivers and clock speed for the signals on the Minder-->Master cables MAY limit the cable length to about 30 ft. Some experts say the cables can be as long as 100’, but that the faster the clock speed, the shorter the cables need to be. Given that possible constraint, the racks were laid out so that all these cable runs would be 30’ or less. The cables are round multiconductor and about 1/4" square each. The bundles of cables connecting a set of FE racks to their VME rack can be as much as 8 square inches in cross section; these bundles connect module-front to module-front (with the exception of the Keeper control cable), and will be routed across the front of the racks.

There are two HV racks along the side of the detector, one each level. Both service the Calorimeter section. Because of the density of FE and RO racks in the Calorimeter section, the HV racks are located approximately at the boundary between the Calorimeter and Spectrometer sections. There is a single 1440 crate in each HV rack. The HV cables must be routed from the HV racks to each FE rack where the phototubes are located. A cable tray specifically for HV cables will be placed across the top of all the upstream racks; this is a separate tray from the one carrying the Minder cables between the FE and RO racks.

LAYOUT AT THE REAR OF THE DETECTOR

The HV for the Spectrometer section comes from a single 1440 crate in a rack at the rear of the detector located on either the upper or lower catwalk level. A cable tray running just below the catwalk will carry the cables to the Spectrometer section FE racks on both levels. There may also be a rack for various monitoring devices located next to the HV rack. (When we understand better where on the walls the chilled water pipes will be mounted, we will know which level is best for these racks.)

Initially, the central DAQ was to be located at the back of the detector. However, where the DAQ central computers are located, there will also be CRTs. The magnetic field from the bare coil sticking out at the back of the detector is likely to be high enough to affect CRTs adversely.

LAYOUT UPSTREAM OF THE DETECTOR

The central DAQ server and computer are located upstream of the detector, preferably along the west wall. The DCS server and central computer will be located in the same place. The two together are expected to take up 3-4 racks. In addition, a rack holding the Ethernet hardware, and the Beams Control Crate, will be located adjacent to the DAQ and DCS.

Each of the RO racks along the side of the detector contains a single ROP. The output of an ROP travels on the PVIC system cable. The PVIC system combines the signals from the 8 total ROPs to ? 2 or 4 ? cables that are run to the single Read Out Controller (ROC) which oversees all DAQ functions. The ROC, the Trigger Farm PCs, and the Data Server PC are the computers that make up the central DAQ. The PCs and servers will all be rack mounted. There will be one table, to hold at least two CRTs, located next to the central DAQ racks.

The central part of the DCS consists of a server and one PC. Both will be mounted into one rack. The DCS communicates with all of its sub-systems via Ethernet, so it seems reasonable to locate the rack holding the Ethernet bridges and other hardware next to the central part of the DCS. The final output of the DAQ will be sent to Feynman for logging, using a dedicated Ethernet connection; so locating the Ethernet hardware adjacent to the central DAQ is also reasonable.

The DAQ central clock system distributes signals to all ROPs, and is overseen by the ROC. The clock system requires input from the GPS receiver, located in the MINOS surface building, and also from the accelerator clock. One rack located next to the central DAQ and DCS will hold an accelerator controls crate, for receiving the clock, and will also hold the crate and modules which get the GPS information from the GPS receiver (via optical cable run down the shaft).

The PVIC, ethernet, clock distribution, and other miscellaneous cables, which run between the detector area and the upstream DAQ area, use a cable tray mounted on the west wall. The tray is mounted about 10 ft off the floor, and runs from the upstream DAQ racks to the start of the detector support structure. On reaching the detector support structure, the various cables are fanned out to one of the other cable trays, which run under the catwalk or along the front of the racks on the upper and lower levels.

The CRTs for local use of both the DAQ and DCS systems are far enough from the Near Coil so that they are not affected by the magnetic field. CRTs can be mounted on a shelf in a rack, but it is more convenient to place them on a table located next to the DAQ and DCS racks. Control of both the DAQ and DCS can be performed from locations outside of the Hall, (in the High Rise, for example), by remote log-in to the appropriate accounts on the DAQ and DCS machines. The CRTs placed in the Hall are used primarily during installation and system integration, and later for local maintenance. There will be some “open” Ethernet ports distributed among the racks around the detector for experts to plug laptops into, for local maintenance and checkout.

UNKNOWNS

The precise location of the central DAQ and DCS racks was arrived at by elimination of other areas, not by picking the “best” place. Whether this is acceptable to the DAQ group has not yet been determined. There is about 70 ft of wall space upstream of the detector support structure on the west side. The quiet electrical power transformers and panel boards take up 35 ft or so of space along the west wall, and it was preferred to place these as close to the racks as possible. The racks for the central DAQ, the DCS, ethernet, controls and clock hardware were then all placed in the upstream west corner, as being the location most out of the way of the area needed to move planes into the Hall during assembly.

The total number of devices used by the DCS, and the precise location of each, aside from the Rack Protection Modules, is not entirely known. However, every rack will have a 120V single phase AC circuit supplying an outlet strip, so wherever the devices are, there will be an outlet nearby for them to use.

Every CPU, both PC and VME-based, and nearly every component of the DCS, will require an Ethernet connection. The layout of the LANs and the layout of cables required for the Ethernet needs to be designed.